to account for the observed phenomena in a satisfactory manner. As is required by this theory it is found that the addition of neutral acetates to a solution of acetic acid diminishes the antiseptic power of the acid, the concentration of the active component of the solution, the hydrogen ion, being under these circumstances reduced to a much smaller value.

Numerous theories have been put forward at different times to account for the formation of natural paraffins, the one received with most favour being that due to Berthelot and developed by Mendeléeff in which the action of steam upon metallic carbides was regarded as the main source of the hydrocarbons. The chief stumbling block to this view was the difficulty of explaining the mode of formation of the naphthenes of the Russian oilfields. The researches of MM. Paul Sabatier and J. B. Senderens on the action of reduced nickel, iron and other metals upon hydrocarbons have now placed the "chemical" theory of petroleum formation on a firm experimental basis. By the direct hydrogenation of acetylene in the presence of nickel they have obtained liquid mixtures of hydrocarbons which can be made to correspond either with American or Caucasian petroleum by varying the conditions of the experiment. To account for the formation of petroleum it is thus sufficient to admit that there are in the depths of the earth free alkali metals and metallic carbides, which in contact with water give rise to mixtures of hydrogen and hydrocarbons. These gases encounter nickel, cobalt or iron in a finely divided state, and thus give rise to the mixtures of hydrocarbons forming natural petroleum.

The additions to the Zoological Society's Gardens during the past week include a Bosman's Potto (*Perodicticus potto*) from West Africa, presented by Mr. Edward Straw; three American Bisons (*Bison americanus*) from North America, presented by H.G. the Duke of Bedford, K.G., P.Z.S.; three Darwin's Rheas (*Rhea darwini*) from Patagonia, a Red Ground Dove (*Geotrygon montana*) from South America, presented by Capt. John L. Marx, R.N.; two Garden's Night Herons (*Nycticorax gardeni*) from the Falkland Islands, presented by Mr. W. Grey Wilson, C.M.G.; an Algerian Tortoise (*Testudo ibera*) from North Africa, presented by Master C. Treverlyn Gill; a Silvery Gibbon (*Hylobates leuciscus*) from Java, deposited; six Ruddy Flamingoes (*Phoenicopterus ruber*) from North America, twenty Alpine Newts (*Molge alpestris*), twenty Newts (*Molge montandonii*) from Roumania, purchased; a Thar (*Hemitragus iemlaica*) born in the Gardens.

THE EQUATORIAL CURRENT ON JUPITER.

That differences occurred in the rate of motion of different markings on Jupiter was first discovered by Cassini in the seventeenth century. But other observers in later years appear to have neglected the systematic study of the planet. His disc was occasionally surveyed, it is true, and the positions of the belts described, but the details were not perseveringly followed. Telescopes were formerly of inordinate length and not very effective in performance, but what was accomplished by Cassini might also have been achieved by others. Jupiter's dimensions are such that comparatively small and imperfect instruments are capable of revealing the principal markings. Herschel never made a thorough investigation of the Jovian spots, though he obtained some observations in 1779 and recognised the difference in their motions. Until the last half of the nineteenth century the planet seems to have been generally surveyed in a desultory manner.

The apparition of the great red spot, however, revolutionised the existing state of things, for it was destined, not only to attract an immense amount of attention to itself, but to the whole visible phenomena presented by the surface markings of Jupiter. When this remarkable object first became perceptible it is not our purpose to inquire; it is certain, however, that as an exceptionally conspicuous feature it was widely observed during the last half of 1878.

It was long thought that the equatorial region of the planet supplied us with the most swiftly moving objects. This was, however, found to be a mistaken impression. The white and dark equatorial spots completed a rotation in about $5\frac{1}{2}$ minutes less time than the red spot, and this meant a difference of velocity amounting to about 250 miles per hour. But it was soon seen that though the equatorial current is much more rapid than the rate exhibited in certain other latitudes, it does not equal the velocity of some other occasional markings in the northern hemisphere.

It is only our intention, however, to refer briefly to the equatorial markings observed during the last quarter of a century. But it must be confessed that the observations are not nearly so continuous and complete as the importance of the subject demands. The results have been sufficiently full for all purposes during the last few years, for several observers, including Mr. A. S. Williams, Rev. T. E. R. Phillips, Captain P. B. Molesworth and others, have obtained a mass of useful materials with reference to the equatorial current. And there seems no doubt that the investigation will be adequately maintained. It is chiefly to the continuity of the observations that we must look for the satisfactory elucidation of the phenomena presented. The equatorial spots have not, it is true, been always in strong evidence. In certain years they are liable to be almost, if not entirely, absent. The breaks, therefore, which occur amongst the accumulated observations are not always to be ascribed to negligence on the part of Jovian students.

At present the equatorial spots are both numerous and conspicuous, and it is to be hoped that a large addition to our observations will be effected during this opposition. The results for preceding years are very extensive and exhibit an irregular, though on the whole a decided, increase in the rotation period, but it would be premature to undertake the collection and reduction of all the materials. The observations must be prolonged over a much more lengthy interval before they can be expected to reveal the information we require. As observed at Bristol, the equatorial spots have shown the following variations in their rotation period, but satisfactory mean results from a number of different objects were only obtained during the last four oppositions:—

	h. m. s.	
1880 ...	9 50 5·8 ...	1 very bright spot
1881 ...	9 50 8·8 ...	,, ,,
1882 ...	9 50 11·4 ...	,, ,,
1883 ...	9 50 12·1 ...	,, ,,
1885 ...	9 50 14·3 ...	,, ,,
1886 ...	9 50 22·8 ...	,, ,,
1895 ...	9 50 34·3 ...	2 black spots
1898 ...	9 50 23·6 ...	23 spots
1899 ...	9 50 24·6 ...	27 ,,
1900 ...	9 50 24·1 ..	18 ,,
1901 ...	9 50 29·1 ...	28 ,,

W. F. Denning.

GERMAN PROGRESS IN OPTICAL WORK.[1]

I purpose dealing with statistics compiled from information afforded me by two German firms and one Austrian, Messrs. Zeiss, Leitz and Reichert respectively, all of whom are well-known makers of microscopes, and the first named of many other optical instruments, including prismatic field glasses, of which, as is well known to you all, they were the originators. I must say that the figures quoted refer approximately to the end of the year 1899, since which date the average rate of increase has been more than maintained. Taking first the firm of Zeiss, in Jena, twenty years ago they employed fifty men; five years later the number had leaped up to 170, or more than three times as many; in another five years the number had practically been doubled, 327 being the precise number; yet another five years saw the number 580; while to-day (1899) they employ the astonishing number (astonishing, that is, for the class of instruments they manufacture) of 946 men, this grand total being made up as follows: theoretical staff, 22; office and dispatch, 36; mechanics, 322; opticians, 371; wood-workers, leather-

[1] Abridged report of a paper entitled "The Secret of German Progress," read before the Optical Society by Mr. Herbert F. Angus, Hon. Sec. of the Educational Committee of the Society.

workers, foundry-men, &c., 129. Of these men, 832 in number, including only those actually at work in the shops, 58, or 7 per cent., are foremen, and 178, or 27 per cent., are youths under eighteen. Turning now to Leitz, in Wetzlar, who, I may say, manufactures microscopes almost exclusively, we find the same steady progress, if not exhibited in such a striking degree. The numbers employed were: in 1879, 35; in 1884, 100; in 1889, 160; in 1894, 200; and at the present day (1899) 253. This number is divided up as follows: theoretical staff, 4; office and dispatch, 9; mechanics, 164; opticians, 60; case work, &c., 16. The foremen number 10, or 4·2 per cent., and the boys 18, or 7·25 per cent. of the total number actually employed in the shops, viz., 240. The firm of Reichert, in Vienna, although smaller, shows an almost identical rate of progress with that of Leitz, the numbers being: employed in 1879, 20; in 1884, 40; in 1889, 75; in 1894, 100; present day (1899), 150; of these, 3 form the theoretical staff, 8 are employed in the office and dispatch department; while of the remainder 120 are mechanics, 30 opticians and 8 case-makers, &c., the boys being 15 per cent. of the whole. I am afraid the numbers given in detail do not always agree with the totals, but I give them as received. . . . .

In the most successful of these firms, that of Zeiss, it will be noticed what a large percentage (27 per cent.) of boys is employed in comparison with the other two—Reichert 15 per cent., Leitz $7\frac{1}{4}$ per cent. It will also be noticed that the percentage (7 per cent.) of foremen is proportionately high. Herein, to my mind, lies the superiority of the firm of Zeiss over competitors of their own nationality, and much more so over us. I do not wish you to understand that I consider the number of boys employed by a firm an unfailing criterion of efficiency and progress; stated in this bald way the proposition is absurd, but, when we take this fact in conjunction with the well-known excellence of the productions of Zeiss (instruments than which no more delicate or difficult of manufacture can be found in the whole range of optics), when, I say, we take these two facts in conjunction, what is to be said of the organisation and system which allows of their coexistence? I think, therefore, that I may be allowed to say that the number of boys employed by Zeiss demonstrates their superiority, and not only that, but that it gives them a *potential* or *latent* power of progress, if I may use the expression. . . . .

I will premise one or two remarks which I have to make on the system of training adopted by saying that in Germany, as no doubt you all know, every young man is compelled by law on entering a trade to attend classes for instruction. Such classes the boys employed by Zeiss, of course, attend. A certain number of apprentices are taken who have, in addition, to attend higher classes, and from whom a higher standard of preliminary knowledge is required (that is, they must pass that examination which reduces the term of service in the army to one year). These higher classes are, however, open to the ordinary working boys, if they have sufficient brains to avail themselves of them. The teaching of optical subjects in the technical school of the town is practically under the firm's control, being subsidised by them, and some, if not all, of the teachers being drawn from the works; half the time spent at this school is during working hours, and is counted the same as attendance at the works. . . . .

This training of the boys and apprentices, the scientific management of the business and the experimental work is supervised by a staff of no less than eighteen mathematicians, physicists and chemists, each of whom holds a University degree; the salaries of these gentlemen, together with the cost of the experimental work undertaken, reach a total of from 6000*l.* to 10,000*l.* per annum. Here, then, in my opinion, you have the secret of German progress—a thorough well-grounded *elementary* training of the workmen, controlled and employed by those possessing a *real scientific* training.

A STEREOSCOPIC METHOD OF PHOTOGRAPHIC SURVEYING.[1]

IN the method proposed in this paper, photographs are taken, with a surveying camera, at a pair of points, the plates being exposed in the vertical plane passing through both stations. A réseau, or a graduated back frame, gives the means of measuring the coordinates of any point on the plates with reference to the optical axis of the camera. After development and fixing, the negatives, or positives from them, are viewed in a stereoscopic measuring machine, which, by combining the pictures, renders possible the instant identification of any point common to the pair of plates. Movable micrometer wires traverse each field, and pointings may be made simultaneously with both eyes. The readings of the micrometers, referred to the réseau, give the three coordinates of the point by direct multiplication by, or division from, constants for the plates, which depend only on the focal length of the camera lens and the length of the base. When a sufficient number of points have been plotted from their coordinates, contour lines may be drawn.

Theory of the Method.—Let A and B (Fig. 1) be the ends of

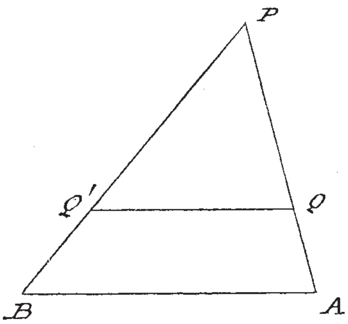

FIG. 1.

the base and Q and Q′ the positions on the photographs of any point P.

Take A as origin and A B as positive direction of x-axis.

Let (X, Y, Z) be the coordinates of P; $(x_a, f, z_a)(x_b, f, z_b)$ the coordinates of Q and Q′.

The equation of A P is:

$$\frac{x}{X}=\frac{y}{Y}=\frac{z}{Z},$$

and if we put $y=f$, we get:

$$x_a=\frac{f}{Y}X$$

$$z_a=\frac{f}{Y}Z.$$

Similarly the equation of B P is:

$$\frac{x-b}{X-b}=\frac{y}{Y}=\frac{z-h}{Z-h},$$

where b and h are the x and z coordinates of B.

Whence,

$$x_b=\frac{f}{Y}(X-b)+b$$

$$z_b=\frac{f}{Y}(Z-h)+h.$$

From these equations we find

$$x_a-x_b+b=\frac{bf}{Y}=e.$$

e is the *stereoscopic difference*, constant for points in any plane perpendicular to A y and vanishing for points at infinity.

The values of the coordinates of P follow:

$$Y=\frac{b}{e}f$$

$$X=\frac{b}{e}x_a$$

$$Z=\frac{b}{e}z_a.$$

A check is afforded by the values of X and Z derived from B P.

$$X=\frac{b}{e}x'_b-b$$

$$Z=\frac{b}{e}z'_b-h,$$

x'_b and z'_b denoting here the coordinates of Q′ referred to B.

[1] A paper read on October 2, 1901, before the South African Philosophical Society, by Mr. H. G. Fourcade, Forest Department, Cape Town.